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MANAGERIAL ECONOMICS -- PAST, PRESENT AND FUTURE.(U)
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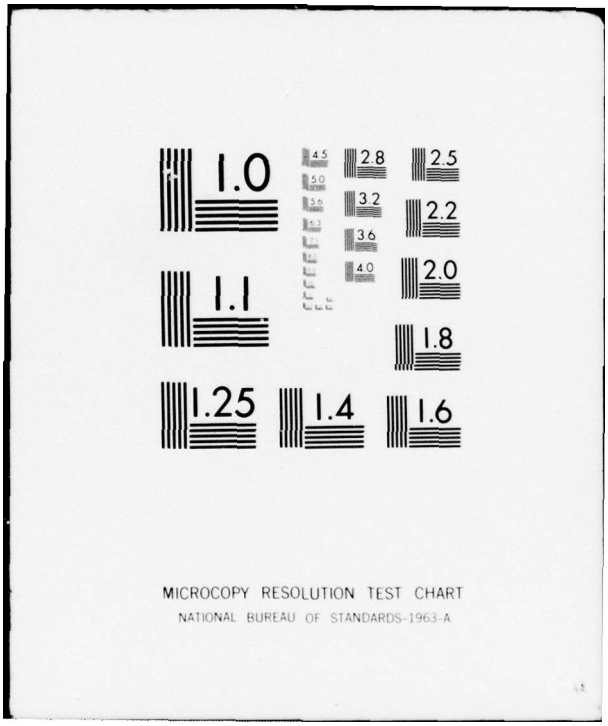
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(6) MANAGERIAL ECONOMICS -- PAST, PRESENT AND FUTURE.

by

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Abstract

In this paper the present state of managerial economics is portrayed against the backdrop of a still-continuing series of methodological developments which began to impact on the civilian management sector in the late 1950's. Historically these developments were associated with changes that were occurring in disciplines like Operations Research, Management Science, and Systems Sciences. The latter involved an orientation toward civilian (private enterprise) management in place of a previous almost exclusive focus on problems in military management. This, in turn, caused these disciplines to interact with and impact on developments in managerial economics.

This paper suggests that managerial economics, and these other disciplines, should (and will) expand their focus in the near future to include management problems in the public sector. This should increase the interactions between them and also improve their ability to deal with problems in private (and military) management as well. Examples of how this might be accomplished are suggested in this paper via PPBS formats for local government and private enterprise management, along with methods of measuring management performance directed to multiple objectives in private as well as public sector management.

What's Past is Prologue

In the 1960 meetings of the American Economic Association in St. Louis, we presented a paper on "The Current State of Managerial Economics,"[1/] which, as it also pointed to the future, argued that much was happening outside "economics proper" and hence all characterizations would be inadequate without attention to these developments. For instance, that paper started with a statement that Joel Dean had used to open his book in Managerial Economics [2/] -- viz., "The purpose of this book is to show how economic analysis [i.e., micro-economic analysis] can be used in formulating [and improving] business policies." It then went on to point out how developments in the then new, but related, disciplines such as operations research, management sciences and systems sciences were likely to infringe on and affect the future course of developments in economics. In particular, our paper pointed out that the accompanying methodological developments in computers (both software and hardware), mathematics and statistics -- and in other methodologies, too -- were likely to give new forms to received economic constructs and they were also likely to alter the boundaries that previously demarcated managerial economics from other fields -- some as yet to be invented. Finally, it was pointed out that this all offered rich possibilities of new problems for research as well as new ways to research them.

1/ The panel session was entitled "Managerial Economics: A New Frontier?" See reference [15] in the bibliography.

2/ Joel Dean [17].

This has all come true. The forms taken in these developments, however, have sometimes appeared strange to those who have viewed them not only from the standpoint of the classical concepts but also from the standpoint of classical methodologies. Hence a few examples might be in order as follows.

Consider, for instance, the concept of marginal cost. Initially, this was almost exclusively developed and applied from the calculus representation of a partial derivative in which variation in only one variable at a time was permitted, with all other variables held constant. This may be called the ceteris paribus approach. But now consider the dual variables of linear programming. Those variables, by way of contrast, utilize what may be called a mutatis mutandis approach in which all variables are simultaneously adjusted to new optimum values with each alteration in the parameters of the original problem.[1/]

Two observations might now be made. First, we observe that the concept of a "marginal cost" as an increment -- indeed an optimal increment [2/] -- to total cost is preserved in either case. Second, we observe that it is possible to teach either the ceteris paribus version or the mutatis mutandis version of marginal cost without reference to the other as in a micro economics course using only the calculus version, or in a course on operations research using only the linear programming version. This is unfortunate

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1/ For further detailed discussions, see Chapter I in [7].

2/ I.e., the increment is itself the minimal one possible under the production function constraints. See, e.g., Diewert [18]. See also Charnes, Cooper and Schinnar [12].

when it happens, however, since it conceals from both instructor and student the related additional opportunities and the potential for increased power in application and/or research. At the most elementary level, for example, it robs both instructor and student of an opportunity for considering ways in which "methodologies" can interact with "constructs" (e.g., the marginal cost construct) to secure improved understanding and a recourse to alternate formulations for a variety of potential uses. It also robs both instructor and student of the increased power and understanding incident to being able to draw upon the (accumulating) knowledge of more than one field at a time. Finally, it also robs them of research opportunities at more advanced levels as when one considers how one might proceed to uncover still further relations and meanings that are, for the moment, still hidden from view.[1/]

Turning to shifts in the boundaries between fields we may observe that this has always been present as when, say, micro economics was incorporated in courses in "engineering economics" so it could be accompanied by suitable engineering problems and examples.[2/] What has happened recently, and continues to happen, however, is an accelerating methodological

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1/ Many such examples can be cited, of course, but it perhaps suffices to observe that the non-optimal values of the dual variables have still not been satisfactorily interpreted for their possible use and/or interest in economics. Cf., e.g., the discussion on pp. 646-647 in A. Charnes and W. W. Cooper, [7].

2/ See, for instance, the discussion of E. L. Grant Principles of Engineering Economy in [15].

revolution. As we have elsewhere observed,[1] substantial alterations in methodology, such as we are now witnessing, are very likely to give rise to shifts in the boundaries of previously identified disciplines, like managerial economics. At the same time they are likely to give rise to new disciplines or new subjects with strange and exotic titles. Finally, they are also likely to produce blends between the old disciplines that may also seem strange to those who are accustomed to the older lines of demarcation.

Examples spring readily to mind. Thus, starting with books like Baumol's Economics and Operations Research [2] one may proceed to books (and courses) in "decision theory" and related areas where it is hard to tell whether one is in statistics, economics, operations research and/or mathematics (e.g., game theory). One can also perceive materials from these newer disciplines themselves being transformed or assimilated in many different ways as when, say, case studies in business policy courses are devoted to studies of the computerized models and related "economics constructs" that some business firms are now using to guide many of their operations. The latter, in particular, is especially to be welcomed as part of the 2-way flow, "from and to the world of affairs," that distinguishes (or should distinguish) a professional school from its pure science counterparts on campus. Concommitantly this "repackaging" should also result in furthering the development of a kind of MBA student, say, who is capable of participating in this kind of 2-way flow by virtue of the training he is now receiving.[3]

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[1] See A. Charnes and W. W. Cooper [8].

[2] W. J. Baumol [4].

[3] See, for instance, the discussion of the survey results in M. Radnor and R. D. Neal "The Progress of Management Science Activities in Large U.S. Industrial Cooperations," [27]. See also A. Charnes, W. W. Cooper and G. Kozmetsky "TIMS in Perspective: 1954, 1964, 1974, 1984?" [10].

2. Prologue

All of the above is to be welcomed, as we have already indicated -- provided one is not averse to basic concepts (like marginal cost) being accorded new characterizations and uses and provided one is not averse to shifting boundaries and strange identities. Persons who have such aversions, however, may secure consolation from the fact that old concepts are being preserved at more basic levels even while these extensions are being effected. In any case there seems little to be done other than to adjust to the stream of such changes -- which are likely to continue into the future -- unless, of course, one wants to contribute to their acceleration.

It is with the latter in mind that we now undertake to point out paths for future development that appear to offer many opportunities for the future. In order to relate these paths to those which have already been traversed, we might observe that managerial economics has previously been regarded as directed almost entirely to the problems of private enterprise management. In the future, however, we think it will turn more toward the problems of public sector management. This can, and should, be done, we think, without losing what has already been solidly accomplished. On the other hand, we may also expect some alteration in these concepts as they are brought up against new problems. A fortiori we must also expect alterations as new methodologies evolve either from these confrontations or from interactions with other disciplines that are also confronting these problems and, in fact, we shall try to illustrate some of the ways in which this may already be happening from research that we (among others) now have under way.

For immediate perspective on the suggested extensions to public sector management problems we might turn to the fields of operations research and management science. As a matter of previous history we might note that the latter (i.e., management science) appeared, circa 1950, at just about the time that operations research was beginning to turn toward civilian (private enterprise) management problems -- and opportunities -- and away from a previously exclusive emphasis on the problems of military management. As a matter of present emphasis we might also note that even a cursory review of literature and the meetings agendas of ORSA and TIMS one generation later -- i.e., circa 1970 -- makes it abundantly clear that they have both already turned toward civilian-governmental management directions. Thus, quite apart from the large social and economic forces impelling us all (including managerial economists) in these directions, the previous history of interactions with OR, Management Science and related disciplines -- which we have already cited -- should also help to open paths along the lines we are now suggesting for managerial economics.

For the most part, the emphasis in virtually all of these developments has been on improved decisions or, more precisely, on improved methods of reaching decisions. This is to say that in OR and MS, just as in managerial economics, the emphasis has been, so to speak, on improved processes of management planning. Almost no attention has been devoted to improved procedures for "accountability" and/or other approaches to the "control" of management behavior. This neglect [1/] has meant that the latter issue has been left in its classical "regulate-vs.-deregulate" form, without

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1/ In managerial economics, this neglect might perhaps be ascribed to a traditional division of labor in which the issues of regulation vs. non-regulation have been traditionally assigned to the industrial organization subdivisions of economics.

any attention to the ways in which the latter might (or might not) be applied to government agencies or to the government-private sector combinations that might appear in the future. In managerial accounting, like in managerial economics, this neglect has also been occasioned, at least in part, by a preoccupation with private enterprise management such as we have already noted. This, in turn, has focussed attention almost exclusively on improved decision making procedures for managers.

Because the problems of improved accountability, and alternatives to regulation, are applicable to both public and private enterprises, however, it seems worthwhile now to explore past (and pending) developments for possibilities they may also offer in directions like these. This is what we propose to do in the remainder of this paper. To do this we shall discuss the following topics in the indicated order: (1) Program Planning Budgeting Systems in Local Governments, (2) Measuring the Efficiency of Decision Making Units and (3) Corporate Social Performance Reporting. Then we shall conclude with a summary and evaluation section. We shall undertake to do this, however, in a way that should also be of interest to those who want to continue with a focus on improved private enterprise management, and, in fact, we shall try to do this in a way that also relates these developments to classical micro-economics constructs and current developments in managerial economics.

3. A Tale of Two City Budgets

PPBS, i.e., Program Planning Budgeting Systems, was one of the important managerial innovations to come from the combined efforts of economists, operations researchers and systems analysts under the direction of R. S. McNamara in the Department of Defense during the early 1960's. It is perhaps of interest therefore to note that McNamara's career paralleled parts of the history we have already recited when, as one of the "whiz kids," he went from the Controller's Office in the Air Forces to the Ford Motor Co. and then back to the Department of Defense. More immediately to the point, however, is the way in which these PPBS concepts may be extended for improved management and management accountability in other types of entities as well.

Here we elect to explore these possibilities at the level of local government budgeting, on the supposition that improved management and management accountability for these entities can thereby also strengthen this element of our present social structure -- which is badly in need of such help. To bring out some of the possibilities that PPBS can offer we proceed to contrast it with the ordinary "Line-Item Budget" that is still used by most U.S. city governments.

An example of such a Line-Item Budget, as used by the City of Pittsburgh, is provided in Exhibit I.1. Here we have eliminated the dollar amounts from this, the opening (summary) page of the Pittsburgh budget, in order to observe that no "programs" are provided. Only the "organization units" are designated along with a record of past and projected appropriations and expenditures.

This kind of Line-Item approach to budgeting might be of limited value for internal management but it is hard to see what interest these classifications and designations can have for the general citizenry. Finally, as if to add emphasis to what we have just said, only input measures (i.e., costs) are supplied so that the only point of reference is a year-to-year comparison such as the "Increase vs. Decrease" column on the right-hand side of Exhibit I.1.

Exhibit I.2, by contrast, shows the program structure as part of the PPBS approach utilized by the City of Sunnyvale, California, in its 1974 budget. The emphasis here is on the programs by which services are delivered to the citizens rather than the organization units which the civil servants happen to occupy for one reason or another in the course of supplying these services. Here, we should also note, there is already a different emphasis in that Exhibit I.2 appears on the outside cover of the Sunnyvale budget thereby signaling its appeal (to everyone) to proceed deeper into the document.

Exhibits II.1 and II.2 carry the contrast between PPBS and Line-Item approaches a step further. Exhibit II.2 constitutes a detail of the total Leisure-Time program budget for Sunnyvale and presumably Exhibit II.1 would constitute a segment of a comparable program for the City of Pittsburgh. Of course, before the latter characterization could really be effected it would be necessary to transfer items like, e.g., Park Patrolmen, to other programs such as Protection of Persons and Property and, doubtless, transfers into as well as out of Leisure Time activities would also be required.

CITY OF PITTSBURGH

COMPARATIVE SUMMARY OF COSTS BY ORGANIZATION UNITS

GENERAL FUND

TITLE	DEPARTMENTAL ESTIMATES 1974 $	APPROPRIATION 1973 $	EXPENDS. 1972 $	INCREASE OR DECREASE '74 OVER '73 $
DEPARTMENTAL:				
COUNCIL AND CITY CLERK'S OFFICE				
MAYOR'S OFFICE				
MUNICIPAL COURTS				
HOUSING CLINIC				
SERVICE CENTER				
COMMISSION ON HUMAN RELATIONS				
CITY INFORMATION SYSTEM OFFICE				
DEPARTMENT OF CITY CONTROLLER				
SINKING FUND COMMISSION				
DEPARTMENT OF CITY TREASURER				
DEPARTMENT OF LAW				
COLLECTION OF DELINQUENT CITY AND SCHOOL TAX LIENS				
CIVIL SERVICE COMMISSION				
DEPARTMENT OF CITY PLANNING				
BOARD OF ADJUSTMENT				
DEPARTMENT OF SUPPLIES				
DEPARTMENT OF LANDS AND BUILDINGS				
DEPARTMENT OF PUBLIC SAFETY				
DEPARTMENT OF PUBLIC WORKS				
DEPARTMENT OF PARKS AND RECREATION				
TOTALS				
NON-DEPARTMENTAL:				
DEBT SERVICE FUND				
REFUNDS, RESERVES AND CONTINGENT FUNDS				
PENSIONS, INSURANCE AND COMPENSATION FUNDS				
JUDGMENTS				
DEPARTMENTAL POSTAGE				
CARNEGIE LIBRARY OF PITTSBURGH				
GRANTS AND DONATIONS				
TOTALS				
GRAND TOTALS				

EXHIBIT I.1

PROGRAM ANALYSIS

CITY OF SUNNYVALE, CALIFORNIA

1973 - 1974

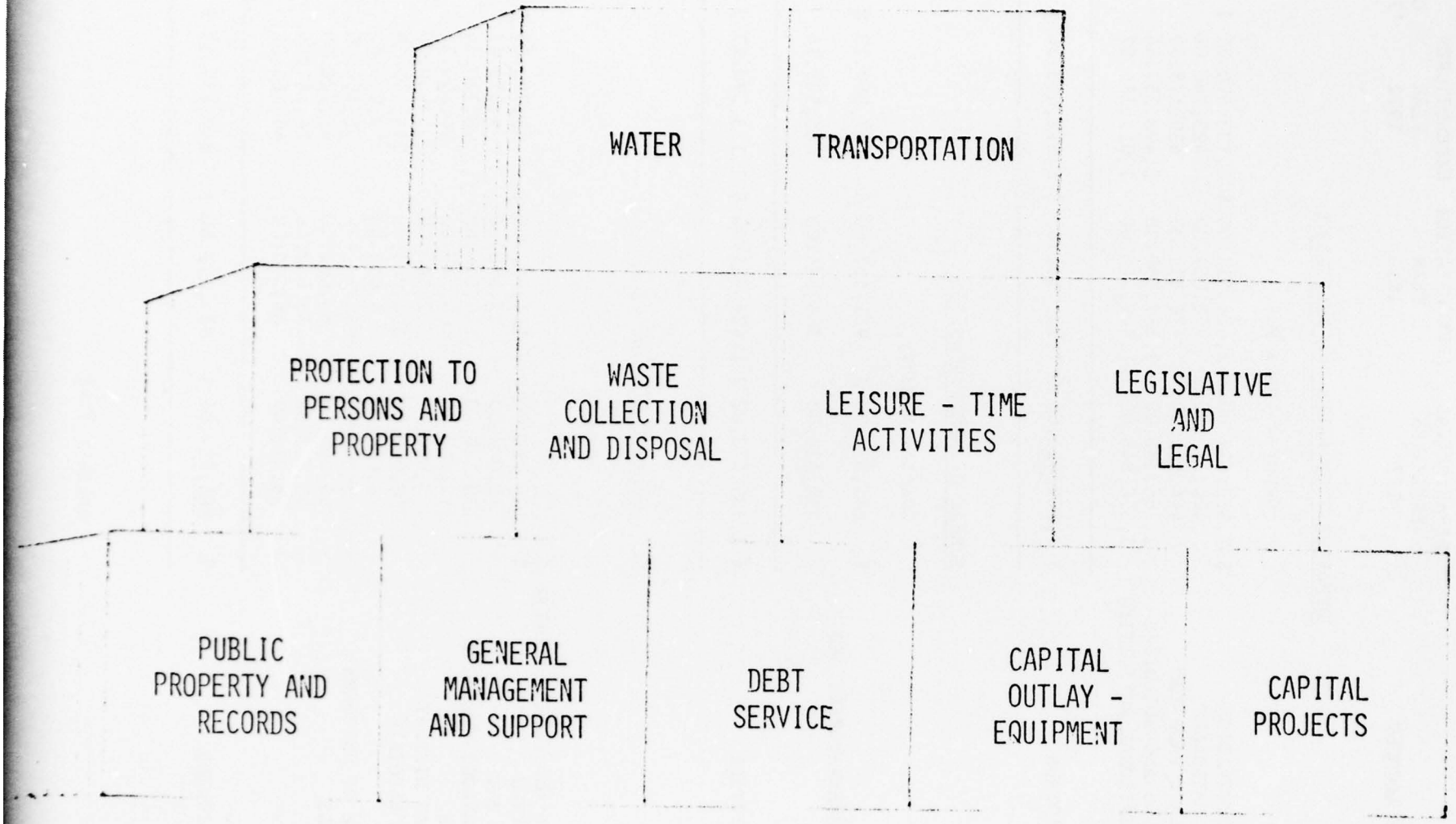

EXHIBIT I.2

CITY OF PITTSBURGH

1973 CODE ACCT. NO.	TITLE OF ACCOUNT	DEPARTMENTAL ESTIMATES 1974	APPROPRIATION YEAR 1973	EXPENDITURES YEAR 1972	INCREASE OR DECREASE '74 OVER '73
	DEPARTMENT OF PARKS AND RECREATION				
	General Summary				
	BUREAU OF ADMINISTRATION	$ 1,339,677.00	$ 1,428,511.00	$ 1,133,390.27	$ 88,834.00-
	BUREAU OF PARK PATROLMEN	420,375.00	453,061.00	425,760.68	32,686.00-
	BUREAU OF HIGHLAND PARK ZOO	444,505.00	476,311.00	439,178.60	31,806.00-
	BUREAU OF GROUNDS AND BUILDINGS	3,266,308.00	3,267,832.00	2,498,157.44	1,524.00-
	BUREAU OF RECREATIONAL ACTIVITIES	1,558,546.00	1,399,446.00	1,017,166.37	159,100.00
	TOTALS	$ 7,029,411.00	$ 7,025,161.00	$ 5,513,653.36	$ 4,250.00
	BUREAU OF ADMINISTRATION				
	General Summary				
	GENERAL OFFICE	$ 885,055.00	$ 921,527.00	$ 647,859.13	$ 36,472.00-
	DIVISION OF CONSERVATORIES AND GARDENS	454,622.00	506,984.00	485,531.14	52,362.00-
	TOTALS	$ 1,339,677.00	$ 1,428,511.00	$ 1,133,390.27	$ 88,834.00-
	GENERAL OFFICE				
	Summary				
1800	SALARIES AND WAGES, REGULAR EMPLOYEES	$ 104,012.00	$ 123,992.00	$ 96,703.07	$ 19,980.00-
1800-1	PREMIUM PAY	15,000.00	23,500.00	9,679.41	8,500.00-
1801	MISCELLANEOUS SERVICES	130,120.00	166,570.00	98,720.54	36,450.00-
1802	SUPPLIES	115,000.00	105,742.00	94,813.25	9,258.00
1802-1	CHRISTMAS DISPLAY	1,000.00	2,500.00	900.00	1,500.00-
1803	GAS AND ELECTRIC	350,000.00	300,000.00	215,543.23	50,000.00
1804	STEAM	4,000.00	4,000.00	3,955.62	----------
1805	PURCHASE OF UNIFORMS	----------	----------	8,400.00	----------
1806	MATERIALS	55,000.00	50,000.00	45,728.06	5,000.00
1807	REPAIRS	42,550.00	76,650.00	24,154.86	34,100.00-
1808	EQUIPMENT	68,373.00	68,573.00	49,261.09	200.00-
	TOTALS	$ 885,055.00	$ 921,527.00	$ 647,859.13	$ 36,472.00-

Exhibit II.1

RESOURCE ALLOCATION ANALYSIS

CITY OF SUNNYVALE

1973-1974

PROGRAM — 246.08 Circulation
FUNCTION — Leisure-Time Activities
OBJECTIVE — Check out and in all books for continuing use by patrons

Fiscal Year	Total Cost of Resources	Service-Cost Indices		
		Work Hours	Production Units*	Unit Cost
1969-1970 Actual	169,557	30,114	707,845	.24
1970-1971 Actual	199,543	35,365	628,786	.32
1971-1972 Actual	177,022	31,897	685,359	.26
1972-1973 Estimated	193,558	34,454	720,677	.27
1973-1974 PROPOSED	210,857	35,280	742,441	.28
1974-1975 Projected	216,195	35,450	755,048	.29
1975-1976 Projected	222,765	35,620	767,049	.29
1976-1977 Projected	231,051	35,790	780,927	.30
1977-1978 Projected	240,470	35,960	794,928	.30
1978-1979 Projected	248,687	36,130	809,052	.31
1979-1980 Projected	257,989	36,300	823,301	.31
1980-1981 Projected	267,426	36,470	836,931	.32

* Books circulated

SPECIAL NOTES —

Quality Goals

- Keep inventory loss to 1% of stock per year
- Check books out at rate of 1 each 5 seconds
- Check books back in at rate of 1 each 3 seconds
- Reshelve books at rate of 100 per hour

Fiscal Year Production Plan

- Process 742,441 books
- Handle 15,000 reserve books
- Operate bookmobile to average 50 stops a week
- Issue 6,000 EDP patron cards
- Update 54,000 patron files
- Include fines on EDP C-Dek for flow control

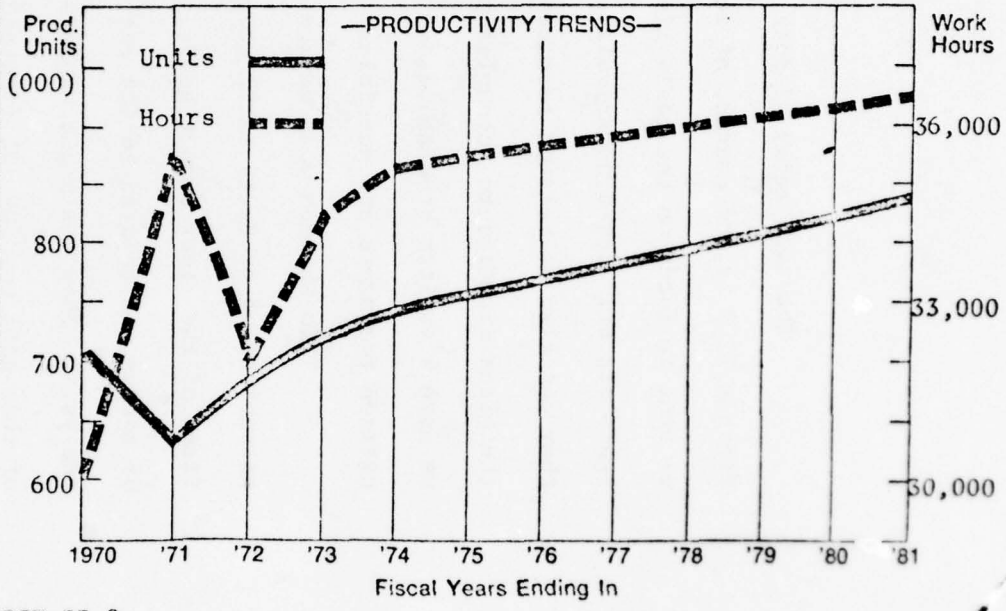

EXHIBIT II.2

The rich array of data supplied by the City of Sunnyvale in Exhibit II.2 is, of course, of interest. For our present purposes, however, we want to focus on the goals listed in the upper right-hand corner. These goals are all stated numerically and so, via suitable mathematical models, they can also be related to each other and to the resources required for the plans directed to accomplishing them in varying degrees.[1/] In any case we have a variety of measures of output, as well as input, to which intelligent citizen responses are possible.

To sharpen what we are trying to say and relate this to needed extensions of received micro-economic constructs, we might focus on the first of the four output goals. This "inventory loss" goal of 1% could, of course, be related to its cost along the lines of, say, a cost/benefit analysis. Then one might explore the cost reductions attending a relaxation of this goal to, say, 2% (instead of 1%) and, indeed, one could also explore the effects this might have on the degrees of attainment that might then be possible for the other goals, too.[2/]

Of course, the indicated relaxation might also have other consequences and these, too, would need to be explored if the suggested analysis is to be complete. For instance, the attendant increase in book losses might take the form of thefts that could give rise to an increase in juvenile deliquency. This would then have to be "costed out" in terms of potential increments to the expenditures this might occasion for the program "Protection of Persons and Properties," and so on. Even if this

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1/ See A. Charnes, C. Colantoni and W. W. Cooper [?] for a discussion of how this might be done via goal programming models.

2/ See section 5 below.

were done, however, it would not necessarily be decisive, for here we encounter the essential nature of any such public entity in our form of society. It cannot -- or at least it should not -- be concerned only with economizing on its own account since its ends are set in the character and behavior of the citizens as well as the quality (and cost) of the life they lead.

Ideally the latter, i.e., the citizens, should be brought into decisions like the above. PPBS with its programmatic format and attendant output-input characterizations and information is a step in this direction. Other developments of both organizational and technological varieties are also required. Among the latter we might number developments in managerial and/or economics technologies. It could also include developments ranging from mathematical models and interactive computer codes of Management Sciences - Systems Sciences varieties, and extend to new kinds of trade-off analyses which would represent extensions from our presently available approaches to choice and decision making in managerial economics.[1/]

These topics will now be addressed in further detail in the sections that follow.

[1/] We leave aside the problem of improving the vehicles for securing citizen participation and interaction during the course of the budgeting -- and goal setting-process. These would probably require cooperation with other social sciences and technologies. See, e.g., N. Johnson and E. Ward [24]. See, also, A. Charnes, G. Kozmetsky and T. Ruefli [13], both in Management Science 19, No. 4, Dec. 1972. See also S. Awerbach and W. A. Wallace [3].

3. Measuring the Efficiency of Decision Making Units

We are suggesting an orientation toward public sector and non-profit decision making entities as an additional dimension for managerial economics in the future. Hence it becomes incumbent on us in our research capacities to look for alternatives to the so-called "bottom line" criterion of "profit" in the privately managed sectors. This is true even if we remain with the "multiple objective" orientations that were noted in our preceding PPBS discussion. Thus, for example, if we want to consider a really suitable "trade-off analysis" format, we first need to ensure that a "trade-off" is really necessary. This will be true, of course, only if we cannot advance one objective without worsening another. Conversely, no "trade-off" is necessary if we can advance any objective without worsening another.

The characterization that we have just supplied suggests a recourse to ideas like "Pareto Optimality" as one way to advance toward the wanted assurances. Thus, if we are willing to borrow the idea of Pareto optimality from the area of welfare economics, say, then we might proceed as follows.

First, we might turn to a little noticed effort beginning in 1957 [1/] by the late M. J. Farrell to develop a measure of efficiency for "decision making units." Such a "unit" might be a "business firm" of the

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1/ See M. J. Farrell [19]. See also Farrell and Fieldhouse [20].

kind that has occupied the center of attention in managerial economics. It might also be a government agency, a hospital, an educational system and it might even be represented by a program directed by some manager with, perhaps, a supporting staff. To avoid a proliferation of names, however, we shall refer to them all as "firms" and we shall use this interchangeably with the term "decision making unit."

In any case, such units are concerned with combining and applying resources to achieve one or more outcomes. We therefore want to be able to evaluate their efficiency (or lack thereof) in doing so.

Figure 1, below, provides us with one way of introducing Farrell's suggested measure. The points $P_1,\ldots, P_6$ depicted there are assumed to represent actual observations for 6 different firms.[1/] The numerical values indicate the amounts of each of two "factors of production" which were used in producing <u>one</u> unit of output. Thus, e.g.,

$$P_2 = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$$

means that $x_1 = 3$ units of the first factor of production and $x_2 = 2$ units of the second were utilized. (Hereafter, we shall also use the term "inputs" as a shorthand expression for "factors of production." We shall also assume that the firms all utilize the "same" factors, but in different amounts, and that the resulting output is also the same.)

[1/] The point P_6 involves certain technical developments which are discussed elsewhere -- see [11]. By and large, these will be omitted from the discussion that follows.

Two basic assumptions are now made in Farrell's development. First, each firm can move along a "ray" to the origin, such as is indicated, e.g., by the broken line from 0 to P_2 in Figure 1. Second, the connecting solid lines between points such as P_4 and P_3 also produce valid production possibilities. We shall refer to the latter as the "isoquant" assumption" and observe that it is equivalent to assuming that the marginal rates of substitution -- also called RTS, the Rate of Technical Substitution[1/] -- between the indicated factors remains constant within each such interval. Observe, however, that this constant changes its value from one interval to another and hence over the whole isoquant it is only piecewise constant. Similarly, the first assumption, which we label as the "ray assumption" is equivalent to assuming constant returns to scale with, in general, a different constant applicable to every firm.

Given these assumptions other aspects of the underlying technologies actually used by these firms are not really relevant to Farrell's proposed measure. Indeed, it suffices for points of intersection between the rays and the isoquant to be valid for the measure which Farrell develops as follows. Let

(1) and

$$\ell(OP_2) = \text{length of "ray" from origin to } P_2.$$

$$\ell(OP_2') = \text{length of "ray" from origin to } P_2', \text{ which is the efficient isoquant point intersecting the ray from 0 to } P_2.$$

Then Farrell's measure of efficiency or, more precisely, his measure of "technical efficiency" for P_2 is

$$(2) \qquad 0 \leq TEF(P_2) = \ell(OP_2')/\ell(OP_2) \leq 1.$$

Farrell also developed corresponding measures of "price efficiency" and "overall efficiency."[1/] He really did not use them very much, however, and neither shall we. In fact, we want to restrict ourselves to the concept of Pareto optimality, [2/] as already indicated, without further reference to "weighting" or "pricing" schemes such as are required for Farrell's concepts of price efficiency and overall efficiency.

Such weighting or pricing would raise a variety of problems for public sector applications, and so we shall impose only the condition that all of the depicted resources used are "valuable". We do not otherwise weight or price them and hence shall proceed in accordance with the following:

Pareto-Koopmans Condition:

> A firm is not efficient if it, or some combination [3/] of other firms, can produce the same amount of output with less of any resource and no more of any other resource. Conversely, a firm is efficient if this is not possible.

We can clarify this definition as follows. Consider, for example, the ray from the origin to P_2 in Figure 1. Via the already specified "ray assumption" we can move to P_2' and then via the "isoquant assumption" we can achieve the same output level by a convex combination of P_4 and P_3. On these assumptions, then, the output for P_2 could be achieved with less of both resources. Hence P_2 is not efficient.[4/]

[1/] See [19].

[2/] Also called "Pareto-Koopmans Optimality" as in [7], Ch. IX.

[3/] I.e., a convex combination such as would be needed to achieve P_2' from P_4 and P_3.

[4/] We can see that P_1 is not efficient for the same reason, i.e., both resources are reduced in the process of bringing it onto the solid line segment connecting P_4 and P_5. In the case of P_6 only one resource is is reduced, however, in order to bring it to coincidence with P_3. This last case requires special attention which we do not want to deal with here. See [11].

The above is fully reflected in the measure we set forth in (2) where efficiency requires $TEF(P_j)=1$. Here, however, we have $TEF(P_2)<1$ and so the decision making of P_2 management was not efficient. On the other hand, the ray to P_3 has $\ell(OP_3') = \ell(OP_3)$ so that also $TEF(P_3)=1$ and the same is true for P_4 which, together with P_3, is then characterized as "efficient."[1/]

Before going on to a model by means of which these TEF measures can be determined numerically -- even in much more complex situations -- we should pause to observe that Farrell refers to this as "practically attainable efficiency." By this he means that empirical evidence, together with his ray and isoquant assumptions, indicate that present managerial capacity (i.e., *the present state of managerial practice*) is up to the job of effecting these resource reductions while maintaining the achieved output. Finally, his approach is mathematical rather than statistical in character while maintaining, both explicitly and implicitly, that the received constructs of economics are not thereby greatly weakened for many applications.

[1/] Note, however, that we cannot rate the efficiency of P_4 relative to P_3 or to any other point on the solid line. To do so would require assumptions of weighting or pricing which, as already indicated, we do not want to make.

RAY AND ISOQUANT REPRESENTATIONS

FOR

SELECTED OBSERVATIONS

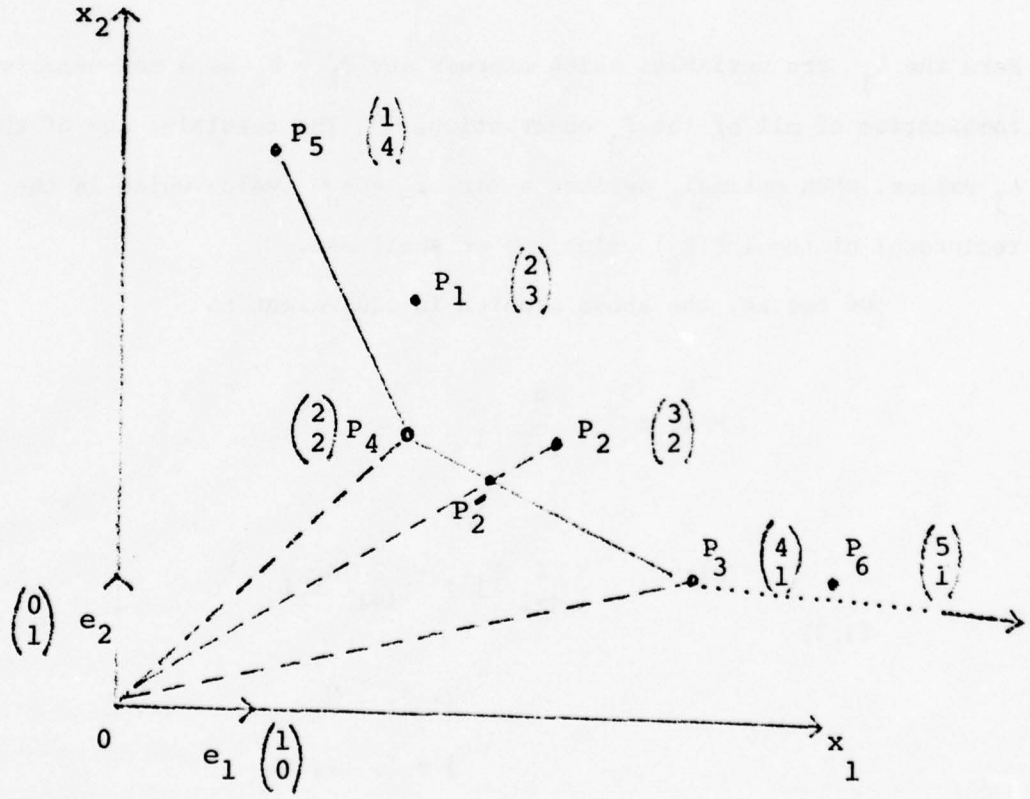

FIGURE 1

Following the development in [11] we now set up the following linear programming problem for determining the wanted measures of efficiency from such observational data:

$$\text{Max. } z_o = \sum_{j=1}^{n} \lambda_j$$

$$\text{with} \quad \sum_{j=1}^{n} P_j \lambda_j \leq P_o \tag{3.1}$$

$$\lambda_j \geq 0, \; j=1, \ldots, n.$$

Here the λ_j are variables which express any $P_k = P_o$ as a non-negative combination of all of the P_j observations.[1/] The resulting sum of these λ_j values, when optimal, defines a Max. $z_o = z_o^*$ value which is the reciprocal of the TEF(P_o) value, as we shall see.

Of course, the above problem is equivalent to

$$\text{Max. } z_o = \sum_{j=1}^{n} \lambda_j$$

$$\text{with} \quad \sum_{j=1}^{n} P_j \lambda_j + \sum_{i=1}^{m} e_i s_i = P_o \tag{3.2}$$

$$\lambda_j, \; s_i \geq 0$$

$$j = 1, \ldots, n,$$

$$i = 1, \ldots, m,$$

in which e_i is the ith unit vector. That is, e_i is the point with unity in row i and zeroes elsewhere. (See e_1 and e_2 in Figure 1.) It is in this form that we will effect our computations, as in Table 1 below, in order

1/ The slack vectors and variables in (3.2) are really considered a part of this characterization.

to determine which of the P_k in Figure 1 are efficient in accordance with the following rules.

Model (3.2) Rule for Farrell Efficiency:

$P_k = P_o$ is efficient if and only if

(4)

i. Its optimal z_o value determined from (3.2) is $z_o^* = 1$, and

ii. The slack variables s_i, i=1, .., m, in (3.2) have zero in every optimum tableau.

Applying (3.2) to Figure 1 we arrange the data in the standard tableau format shown at Stage 0 of Table 1, below. Then we apply the simplex method of linear programming to obtain the optimum $z_o^* = 7/6$ value shown in the $z_j - c_j$ row under $P_o = P_1$ at Stage 3*. Reference to i above then shows that P_1 is not efficient. On the other hand, both P_4 and P_5 are in the optimum basis [1/] and it therefore follows that the managements associated with these two firms are efficient.

To see what this means and relate it to Figure 1 we observe that Stage 3* immediately give us the optimum solution as

$$\frac{5}{6} P_4 + \frac{2}{6} P_5 = P_1.$$

I.e., by reference to the values shown under $P_o = P_1$ at Stage 3* we have $\lambda_4 = \frac{5}{6}$ and $\lambda_5 = \frac{2}{6}$. Multiplying this last expression by $TEF(P_1) = 1/z_o^* = 6/7$, however, converts this to

$$\frac{5}{7} P_4 + \frac{2}{7} P_5 = \frac{6}{7} P_1.$$

1/ As shown in the stub section of Table 1 at Stage 3*.

In other words, z_o^*, or rather its reciprocal, is the requisite scale factor which moves P_1 onto the solid line connecting P_4 and P_5 in Figure 1 and so 6/7 $P_1 = P_1'$ for this case. In managerial economics terms this is interpreted to mean that the management of P_1 could have produced the same output with only 6/7 of each of the inputs utilized -- or, conversely, it could have amplified its output by a factor of $z_o^* = 7/6$ from the inputs utilized.

To complete our analysis of Figure 1 we next inquire whether P_2 is efficient. To avoid backtracking we move from where we are via the dual method. This is done in Table 1 by reproducing Stage 3* in a new Stage 4 and then proceeding to a new optimum at Stage 5*. The solution at the latter stage gives $z_o^* = 7/6$ so that P_2 is also not efficient while the associated basis set for this same solution is efficient.

Our solutions have now designated P_3, P_4 and P_5 as efficient and P_1 and P_2 as not efficient. Furthermore, the data needed for determining the efficiency of P_6 is also at hand so that by a few suitable manipulations [1/] we obtain $z_o^* = 1$ but also $s_1 = 1$. The latter is a slack variable and hence P_6 fails to conform to condition ii for efficiency. In fact, this $s_1 = 1$ together with $z_o^* = 1$ means that $x_1 = 5$ can be replaced with a new $x_1 = 4 = 5 - s_1$ and this would bring it onto the efficient isoquant (at P_3) without any further adjustment.

[1/] See [11] for details.

TABLE 1

ILLUSTRATION OF SIMPLEX AND DUAL METHOD CALCULATIONS

SIMPLEX METHOD

Stage	Basis		Structural Vectors					Slack Vectors		Stipulations Vector	Optimal Basis
	c_B	B	P_1	P_2	P_3	P_4	P_5	e_1	e_2	$P_o = P_1$	
0	0	e_1	2	3	4	2	1	1		2	
	0	e_2	3	2	1	2	(4)		1	3	
	$z_j - c_j$		-1	-1	-1	-1	-1				
1	0	e_1	5/4	5/2	(15/4)	3/2		1	-1/4	5/4	
→	1	P_5	3/4	1/2	1/4	1/2	1		1/4	3/4	
	$z_j - c_j$		-1/4	-1/2	-3/4	-1/2			1/4	3/4	
2	1	P_3	1/3	2/3	1	(2/5)		4/15	-1/15	1/3	
	1	P_5	2/3	1/3		2/5	1	-1/15	4/15	2/3	
	$z_j - c_j$					-1/5		1/5	1/5	1	
→	1	P_4	5/6	5/3	5/2	1		2/3	-1/6	5/6	
3*	1	P_5	2/6	-1/3	-1		1	-1/3	2/6	2/6	P_4, P_5
	$z_j - c_j$		1/6	1/3	1/2			1/3	1/6	7/6	

DUAL METHOD

										$P_o = P_2$	
	1	P_4	5/6	5/3	5/2	1		2/3	-1/6	5/3	
4											
←	1	P_5	2/6	-1/3	(-1)		1	-1/3	2/6	-1/3	
	$z_j - c_j$		1/6	1/3	1/2			1/3	1/6	4/3	
	1	P_4	5/3	5/6		1	5/2	-1/6	2/3	5/6	
5*											P_4, P_3
	1	P_3	-1/3	2/6	1		-1	2/6	-1/3	1/3	
	$z_j - c_j$		1/3	1/6			1/2	1/6	1/3	7/6	

In any case, we have now identified 3 points as efficient and 3 points as inefficient in Figure 1. We have also supplied explicit numerical measures and interpretations, along with formulations and computational routines that extend in a straightforward manner to many more dimensions than cases like the one shown in Figure 1. Furthermore, the suggested formulation was also designed to produce even more details of general economic interest. For instance the values in the $z_j - c_j$ row under the unit vectors in each optimal tableau correspond to the optimal values for the variables in the associated dual problem. By analysis of the latter problem it can be shown that these values correspond to the slopes of the corresponding isoquant segments. Thus for the segment extending between P_4 and P_5 we have, from the tableau at Stage 3*,

$$S(P_4,P_5) = \{(x_1,x_2): \frac{1}{3} x_1 + \frac{1}{6} x_2 = 1;\ 1 \leq x_1 \leq 2,\ 2 \leq x_2 \leq 4\}.$$

The slopes for the segment between P_3 and P_4 may then be read from the Tablean at Stage 5* to give

$$S(P_3,P_4) = \{(x_1,x_2): \frac{1}{6} x_1 + \frac{1}{3} x_2 = 1;\ 2 \leq x_1 \leq 4,\ 1 \leq x_2 \leq 2\}.$$

This means that we have the marginal rates of substitution,[1/] the associated marginal productivities and, indeed, the entire production function, as wanted.

[1/] Also called the rate of technical substitution.

Furthermore these are all secured without extra effort from the solutions that we have already achieved in our search for a means of identifying and measuring the relative efficiency of the decision making units we have been considering.

In the present paper we shall not pursue these latter topics or their possible applications to a variety of private sector management problems.[1/] Instead we shall extend our previous model to the multiple output case since, almost certainly, that will be the situation encountered for the public sector applications with which we are concerned. By this we mean that it will generally be awkward, if not impossible, to utilize prices (or other weights) to reduce the multiple outputs to a single dimension such as may be done with the sales figures, say, of a private enterprise firm. Nevertheless, we shall want a simple summary for identifying and measuring decision making efficiency and, in fact, we shall orient our extension so that the same conditions as were set forth for Model (3.2) continue to apply.

To do this we now replace our previous P_j definition with

$$(5) \quad P_j = \begin{pmatrix} Y_j \\ X_j \end{pmatrix} \qquad j = 1, .., n$$

where Y_j represents an ordered collection of outputs and X_j an ordered collection of inputs. That is, we now allow each of our $j = 1, .., n$ firms to have multiple outputs, instead of only one, while continuing the multiple input situation as before.

[1/] See, e.g., the use of Farrell efficiency measures by Bo Carlsson in [5] to assess, by reference to Leibenstein's concept of "X - efficiency" ([25] and [26]), whether Swedish manufacturing firms were operating at or near the frontier of their possible (relative) efficiencies.

Here again we are concerned with developing a TEF measure from observational data which we do by replacing (3.1) with

$$\text{Max. } z_o$$

with

$$(5.1) \qquad \begin{aligned} -\sum_{j=1}^{n} Y_j \lambda_j + Y_o z_o &\leq 0 \\ \sum_{j=1}^{n} X_j \lambda_j &\leq X_o \\ \lambda_j &\geq 0, \; j = 1, .., n. \end{aligned}$$

Straightforward arguments can be used to show that (4) continues to apply.[1/] Instead of repeating these arguments here, however, we shall relate (5.1) to (3.1) via the following

$$\text{Max. } z_o$$

with

$$(5.2) \qquad \begin{aligned} -\sum_{j=1}^{n} y_j \lambda_j + y_o z_o &\leq 0 \\ \sum_{j=1}^{n} X_j \lambda_j &\leq X_o \\ \lambda_j &\geq 0, \; j = 1, .., n. \end{aligned}$$

Here the lower case y_j and y_o values refer to the single output which was previously used to "norm" the X_j components in order to bring them onto the unit isoquant. [2/]

[1/] See [11].

[2/] I.e., each firm's own unit isoquant, as distinguished from the efficient isoquant shown in Figure 1.

Of course the concept of an isoquant becomes ambiguous for the multiple output case and, indeed, the concept of a production function needs to be replaced by the more general concept of a "production possibility surface."[1/] Otherwise everything else goes through as for the single output case, including values of the dual variables which correspond to the components of the associated activity vectors.

Turning to (5.2), however, we see that we can associate the Max. $z_o = z_o^*$ value with an isoquant related to y_o. Alternatively we can trace out the entire production function surface, if wanted, by parametrically varying y_o.[2/] In any case, we will need to adjust the observed y_o value as follows in order to bring it up to this surface. First, we replace the observed y_o by a new $y_o z_o^*$. Then we add the slack, if any, to this new output level and, simultaneously, subtract from the components of X_o any slack that may be present in the inputs. In this manner we achieve a new $\hat{P}_k = P_o$ which is efficient, and without some such adjustment we cannot otherwise rigorously accord any real economic meaning to the observed y_o values.[3/]

We are now also in a position to observe some of the alterations that are already in process via the altered methodology that we are here applying to the usual production function concept. First we observe that we are not here proceeding with "aggregate production function" analysis in the manner that is customary in industry- or economy-wide studies. We are dealing instead with individual decision making units.

1/ See, e.g., Arrow and Hahn [2].

2/ See [11].

3/ This should not be interpreted to mean that functional forms fitted to such unadjusted observations have no value. We only mean to say that the latter do not, in general, correspond to the really rigorous requirements of economic theory.

In this way we are also staying rather close to the context from which the concept of a production function originated.

On the other hand, we are also not proceeding in the manner that is customary in the study of production functions at the level of individual plants or companies. Instead we are dealing with all such entities simultaneously, in census fashion, as we define our production functions or the isoquants to which they relate. See, e.g., the way the isoquant in Figure 1 is derived from the firms depicted there.

In some ways we are proceeding in a manner that is suggestive of Alfred Marshall's classical concept of a "representative firm."[1/] However, our referent is plural rather than singular. Also the term "representative" would need to be replaced by "efficient representatives."

These brief characterizations suffice to indicate some of the changes that can occur, and are likely to be encountered, as we proceed in the directions that we are suggesting for an expanded managerial economics. Hence we may now close this section since, via (5.1), we have also indicated how these extensions may be effected to the multiple output-multiple input situations which are characteristic for public sector decision making units -- which, as we noted earlier, are presently lacking in such measures of efficiency. We only need to note that our measure (unlike profit in the private sector) does not assess the directions taken by the activities under consideration. That is, it does not assess whether the goods and service should have been produced at all. It only measures efficiency relative to other decision making units that have taken the same directions.

1/ See, e.g., the discussion in Stigler [28].

5. Corporate Social Reporting

The developments in the preceding section showed how private sector managerial econcomics concepts -- viz., production functions and related concepts -- could be used to obtain increased accountability for managers of public sector decision making units. By suitably altering those private sector (managerial economics) concepts we were able to provide a model and related interpretations so that a legislative body, say, might enhance its ability to evaluate the efficiency of managers responsible for carrying out its programs.

Having thus indicated how private sector (efficiency) concepts might be brought to bear on public sector management, we might now proceed in an opposite manner with respect to private sector managerial behavior. We will do this by means of a mathematical modeling approach to the multiple objective problems which, as we noted, are characteristic of the budgeting problems in public sector entities. This will also give us a chance to examine alternatives to the scalar (single objective) optimizations such as cost minimization, profit maximization, etc., which have been characteristic of past approaches in managerial economics.

An easy entrance into this topic is provided via the following goal programming formulation,

$$\min u = \delta_1^+ + \delta_1^- + \delta_2^+ + \delta_2^- + \delta_3^+ + \delta_3^-$$

subject to:

$$12 \geq 3x_1 + 4y_1 + 2x_2 + 2y_2$$

$$10 \geq 5x_1 + 5y_1$$

$$(6) \qquad 6 = x_1 + 2y_1 \qquad -\delta_1^+ + \delta_1^-$$

$$3.5 = x_1 + y_1 + \tfrac{1}{2}x_2 + \tfrac{1}{4}y_2 \qquad -\delta_2^+ + \delta_2^-$$

$$5 = 5y_2 \qquad -\delta_3^+ + \delta_3^- \ ,$$

in which all variables are also constrained to non-negative values.

We proceed to interpret this model as follows. The first pair of constraints represent the physical plant in the form of two machines with capacity values and processing times as shown. Thus,

$$(6.1) \qquad 12 \geq 3x_1 + 4y_1 + 2x_2 + 2y_2$$

means that 12 hours of capacity is available on the first machine. The subscripts j=1,2 on the variables x and y identify the <u>products</u> while the quantities assigned to each x and y represent different <u>processes</u> for producing the same product.

Similar interpretations apply to the constraint for the second machine, which is

$$(6.2) \qquad 10 \geq 5x_1 + 5y_1 \ .$$

Here the 10 hours of available machine capacity is utilized at the rate of 5 hours per unit, no matter which process is used to produce product j=1. This is not the case for (6.1), however, where, as can be seen, the process associated with x_1 "costs" less in time utilized per unit output than is the case for the process associated with y_1.

Since the resulting product j=1 is identical, at least as far as its market is concerned, considerations of profit maximization would rule out the latter process. We are applying a multiple objective optimization, however, and so we first need to take account of the goals before effecting any such elimination. These are impounded in the last 3 constraints of (6).

The idea of goals being somewhat alien to managerial economics, we turn next to the sister field of "managerial accounting", where a perhaps closer relation with internal organization design and hence organization theory makes such ideas more familiar.

The first of the three goal constraints, viz.,

$$(6.3) \qquad 6 = x_1 + 2y_1 - \delta_1^+ + \delta_1^-$$

is associated with increasing the amount of minority employment. The goal, as specified on the left of (6.3), is 6 hours of such employment, with x_1 contributing one such hour per unit utilization and y_1 contributing two such hours per unit utilization. Evidently the latter is twice as effective in this constraint as the former. Hence we cannot discard the process associated with y_1 until we know more about how this goal relates to the other goals and to the overall objective.

The next goal constraint, viz.,

$$3.5 = x_1 + y_1 + \tfrac{1}{2}x_2 + \tfrac{1}{4}y_2 - \delta_2^+ + \delta_2^- \tag{6.4}$$

is directed to profit -- or, really, quasi rent, since it reflects only the variable components of costs and receipts. Since we are now approaching this topic from the standpoint of managerial accounting, however, we shall call this the "contribution margin".[1/] This goal is \$3.50, with contributions being recorded at \$1 per unit for j=1, the first product. This contribution is the same whether the process associated with x_1 or the process associated with y_1 is utilized in producing this product. The same is not true for the second product. The process associated with x_2 contributes \$.50 per unit to the \$3.50 goal while the process associated with y_2 contributes only \$.25 per unit.

Turning to the final goal constraint, we have

$$5 = 5y_2 - \delta_3^+ + \delta_3^- \tag{6.5}$$

which means that only the process associated with y_2 contributes to their goal. The 5 units on the left of (6.5) represents this goal which is in the form of a desired reduction in, say, tons of the particulates emitted when the second product is produced.

A shared characteristic of these goal constraints is that they can always be satisfied for arbitrary x_j, y_j values[2/]. Thus the

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[1/] Technically, this is the contribution to profit and overhead resulting from per unit sales receipts in excess of their direct and indirect variable costs per unit.

[2/] See [6] for further discussion and elaboration of the subject of goal programming.

fact that the goals of profit[1/], minority employment and emission control are not consistent, or the fact that perhaps none of them are wholly compatible with the company's capacities, is not decisive. The real issue resides in the δ_j^+ and δ_j^- values which result from these x_j, y_j choices in each constraint.

To resolve these issues of choice we formulate the objective as in (6), which is a goal programming model with equal weights assigned to every deviation. For lack of a better word, we shall refer to these as "managerial evaluation units" which because they are all equal, are assigned at one per unit deviation. The "min. u" value then reflects the sum of these deviations when the program choices are brought "as close as possible" to goal attainment.

If we solve (6), as is easily done by standard methods of linear programming, we obtain

$$(7.1) \qquad x_1 = 0, \quad y_1 = 2, \quad x_2 = 1, \quad y_2 = 1$$

for which

$$(7.2) \qquad \delta_1^- = 2, \quad \delta_2^- = 0.75,$$

and all <u>other</u> δ_j^+ and $\delta_j^- = 0$. Thus min u = $\delta_1^- + \delta_2^- = (2.75)$, where we have utilized the parenthesized style of accountants to mean that this is the net "below goals" sum. In fact this (2.75) value is also the gross sum since no $\delta_j^+ > 0$, i.e., no "above goal values" are associated with the program (7.1).

[1/] Which here assumes the form of a contribution margin goal.

Notice that, in any case, this "best possible" plan deviates from the goals. This will normally be the case, and, furthermore, it is likely that the "actuals" that subsequently materialize will deviate from the plan, and so on. Hence it becomes important for us (or someone) to consider how this information may best be presented to management -- and possibly others in a more general accountability statement.

A possible start in these directions, along with a suggested format for a tradeoff analysis statement is presented in Tables 2 and 3. For this discussion, we visualize these as reports for internal management consideration only -- perhaps prior to a public disclosure of the resulting decisions.

Assuming that the usual cost and production reports are already assimilated in the regular reporting routine we have arranged these as goal oriented reporting statements. In particular, Part I provides a plans-to-goals comparison which, in stripped down form, recapitulates what we have already said. It, however, organizes this information in a single table that can subsequently be supplemented by a plans-to-actuals statement, too, from which new goal settings and new evaluations might also be undertaken in the light of corresponding time series relations, and so on.

Part II of Table 2 is based on information obtained by solving the problem that is dual to (6). It is called a goal impact statement because there is no allowance for the amount of the investment needed to obtain the indicated increases in capacity. The purpose is only to explore the impact on each goal from undertaking a one hour increase in the capacity of each of the two machines.

As this table shows the impact from M_1, the first machine, is entirely on the contribution margin and the impact from M_2 is entirely on employment. Increasing the capacity of both machines simultaneously will thus reduce total below-goal deviations from (2.75) to (2.10) via their resulting impact which increases the contribution to profit and overhead by \$0.25 and the total minority employment by 0.4 hours.

Proposed Accountability Statement

for

Plans to Goal Comparisons

PART I: Operating Programs

	Income Statement ($)		Employment Statement (MOWHRS†)		Environment Statement (TONS)	Total MEUNITS ‡‡
Goals	Contribution Margin	3.50	Minority 6	Other ...	-5	0
PROGRAMS	Sales	...	2	...	-1	...
	Costs	...	2	...	-4	...
	Contr. Margin	2.75	4	...	-5	...
Planned Deviation		(0.75)	(2)	...	0	(2.75)

PART II: Goal Impact Evaluation Analysis for New Investment Alternatives

Facility to be Incremented (HRS)	Impact Per Unit Facility Increment				Total MEUNITS ‡‡
	Contribution Margin	Employment (MOWHRS)		Environment (TONS)	
M_1	0.25		...		0.25
M_2		0.40	...		0.40
M_1 and M_2	0.25	0.40	...		0.65

M_1 = First Machine

M_2 = Second Machine

† MOWHRS = Man or Woman Hours

‡‡ MEUNITS = Management Evaluation Units all weighted at one unit per unit deviation from each goal.

Table 2

Management also needs to know something more about objectives that might be used in lieu of these goals. Table 3 provides this kind of information and it also provides a basis for studying trade-off possibilities either en route to choosing weights for (6) or for effecting a choice among the further alternatives that Table 3 brings to light.

To obtain the details for Table 3 we proceed as follows. First we replace the goals by the following objectives.

Contribution Margin:

$$(8.1) \qquad \max.\ z = x_1 + y_1 + \frac{1}{2} x_2 + \frac{1}{4} y_2$$

Minority Employment:

$$(8.2) \qquad \max.\ r = x_1 + 2y_1$$

Emission Reduction:

$$(8.3) \qquad \max.\ s = 5y_2.$$

In other words, we bring the goals up into the functional for the indicated maximizations, one at a time, while retaining the machine capacity constraints that were set forth in (6).

Proceeding in the indicated manner we find that the contribution margin goal in (6.4) was actually maximal. The goal established for minority employment in (6.3), however, exceeded the maximum that the physical capacities will allow. Plans 1 and 2 which are shown in Table 3 are, in fact, alternate (extreme point) optima, but both fall short of the indicated goal by 2 hours.

The emission goal, unlike one for minority employment in (6) is nowhere near maximal. In fact, an emission reduction of 30 particulate tons is possible, as shown in the final row of Table 3. This exceeds the goal specified in (6.5) by 25 tons.

On the other hand, the objective of emission reduction is in conflict with both the contribution margin and employment goals. This is to say that as emissions are increased both of the latter goals are improved. As the contents of Table 3 make clear, for example, a reduction from $y_2 = 6$ to $y_2 = 2$ makes it possible to improve the latter but not the former. See Plan 2 in Table 3. Continuing on to Plan 1, however, with $y_2 = 0$ converts the goal excess for emissions to a goal deficiency. Since Plans 1 and 2 are extremes, however, it is possible that something in between will produce a better result for emissions without worsening the position on minority employment. In fact taking a 50-50 combination of the two Plans returns us to (7.1) and (7.2) which, we recall, was optimal for the previous goal programming model.

Alternative Objectives

and

Trade-Off Possibilities

If the Objective Indicated Below is Optimized	The Plan Will Yield These Results				
	Goal Deviations			Program	
	Contribution Margin $	Minority Employment (MOWHRS)	Emission Reduction (Tons)	Amt. of Product 1	Amt. of Product 2
Contribution Margin	0	4	5	$x_1 = 2$ $y_1 = 0$ 2	$x_2 = 3$ $y_2 = 0$ 3
Plan 1 Minority Employment	$\frac{1}{2}$	2	5	$x_1 = 0$ $y_1 = 2$ 2	$x_2 = 2$ $y_2 = 0$ 2
Plan 2	1	2	-5*	$y_1 = 0$ $y_1 = 2$ 2	$x_2 = 0$ $y_2 = 2$ 2
Emission Reduction	2	6	-25*	$x_1 = 0$ $y_1 = 0$ 0	$x_2 = 0$ $y_2 = 6$ 6

* Exceeds goals by indicated amount.
All other deviations are below goals indicated in (6).

Table 3

At this point the tradeoff analysis may be continued by studying facilities alterations again in the light of these new alternatives. We shall not do that here.[1/] The point we seek to make instead is that these tradeoffs are multi-dimensional and that much remains to be done in the way of facilitating such analyses. This might be done en route, perhaps, to a study of weighting possibilities that would relieve internal management of the chore of effecting such choices. It might also be done en route to an improved system of accountability that would provide increased public understanding of the reasons for such managerial choices and, of course, there is no reason why progress on this front should impede progress in the direction of improving management decision processes as well.

1/ See [16] for further dicussion of these and other possibilities.

6. Summary and Conclusion

In the opening sections of this paper we discussed past accomplishments of managerial economics as background for examining some of the subsequent interactions with "outside" forces that have brought it to its present state. Thus, starting as an exporter of micro-economic concepts to activities like Managerial Accounting and Engineering Economics, the field of Managerial Economics began to interact, circa 1960, with disciplines such as Operations Research, Management Sciences and Systems Sciences. The resulting contacts with new methodologies have produced a variety of transformations, such as we noted in the opening sections of this paper, while leaving the underlying concepts of economics relatively intact, at least at very basic levels.

Contrasting this paper with one that predicted some of these developments in 1961, we may say that we are now advocating (if we are not predicting) an expansion in the focus of managerial economics. In particular, we are arguing that this focus should be expanded to include the management of public as well as private enterprises. Note, however, that we are not advocating abandonment of the latter in pursuit of the former and the same is true for our advocacy of the need for improved methods of accountability en route to new alternatives to the "regulation vs. de-regulation" impasse which we presently occupy.

Starting with a discussion of PPBS vs. Line Item budgeting at local government levels in section 3, we proceeded to discuss ways of ascertaining and evaluating the efficiency of "decision-making units" in section 4. Although our emphasis was on public sector management, the concepts and methods utilized in section 4 are applicable to other sectors as

well. Indeed they may be used as a tool for evaluating efficiency in cases where the direction of activities [1] is taken as a given -- e.g., as when competitive forces are weak or absent.[2]

Partly to provide further perspective, we next turned, in section 5, to examine possible developments for trade-offs, and other analyses, in the area of social responses by private sector managements. Our development emphasized internal reporting, however, and consequently also emphasized improved practices for decision making by internal management rather than addressing the issues of accountability and control directly -- since to do so would have led to external citizen-type reporting systems and interactions.

Even to deal with such internal reporting systems we found it necessary to appeal to Managerial Accounting-Managerial Economics combinations. To go into issues of public disclosure, etc., would have carried us still further into accounting and then into auditing, and so on. For instance, in the area of accounting-accountability relations we would have found it necessary to note some of the recent developments in corporate social reporting.[3] Then we would have evolved into discussing possible extensions in accounting from "financial" to "corporate reporting." [4]

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[1] E.g., as in the choice of products and services to be produced.

[2] Cf., e.g., the discussion of X efficiency in Stigler [28]. See also Farrell [19] and Farrell and Fieldhouse [20].

[3] See, for instance, the recently released American Institute of Certified Public Accountants report [1].

[4] Cf. for instance the recently released report [29] by The Institute of Chartered Accountants of England and Wales.

This, in turn, would have led us into the developments of "comprehensive auditing" which extend the traditional financial-statement audits to include all phases of management.[1/] From the latter standpoint we would have found it necessary to comment on the reversal this entails for the auditor-manager relations that now exists in financial statement CPA attestations. Typical of this reversal, for instance, are the practices of the U.S. General Accounting Office in which the audit area is selected by them -- i.e., the auditor -- sometimes over strong management protests.[2/] This means that the auditor also assumes full responsibility for the report and which he then indites and releases with management given a chance to reply, perhaps in the same report.[3/]

Pursuit of the latter topics would obviously carry us far afield from our present assignment. We therefore now bring this paper to a close and therby resit the inviting prospects that some of these developments appear to offer as possibilities for alternatives to the regulation vs. de-regulation impasse which we noted earlier in this presentation.

[1/] Including the "propriety" of management objectives and methods as well as their "efficiency" and "effectiveness." See [30].

[2/] See, for instance, the objections of the Attorney General recorded in the GAO's audit report on the FBI [30].

[3/] See the discussion in [14].

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13. ABSTRACT

In this paper the present state of managerial economics is portrayed against the backdrop of a still-continuing series of methodological developments which began to impact on the civilian management sector in the late 1950's. Historically these developments were associated with changes that were occurring in disciplines like Operations Research, Management Science, and Systems Sciences. The latter involved an orientation toward civilian (private enterprise) management in place of a previous almost exclusive focus on problems in military management. This, in turn, caused these disciplines to interact with and impact on developments in managerial economics.

This paper suggests that managerial economics, and these other disciplines should (and will) expand their focus in the near future to include management problems in the public sector. This should increase the interactions between them and also improve their ability to deal with problems in private (and military) management as well. Examples of how this might be accomplished are suggested in this paper via PPBS formats for local government and private enterprise management, along with methods of measuring management performance directed to multiple objectives in private as well as public sector management.

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